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DESCRIPTION OF A NEW SPECIES OF *HALGERDA* FROM THE
INDO-PACIFIC WITH A REDESCRIPTION OF
HALGERDA ELEGANS BERGH, 1905

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A new species of *Halgerda*, *H. albocristata* sp. nov. is described based on several specimens all having morphological similarities with *H. elegans*. *Halgerda albocristata* is known from Okinawa, Papua New Guinea, Guam, Marshall Islands and Indonesia. Comparison is made with the original description and newly collected material of *Halgerda elegans* Bergh, 1905 and with other described *Halgerda* species. The coloration, reproductive and the radular morphology of this new species differ significantly from *H. elegans* and other previously described *Halgerda* species. The presence of some anatomical consistencies and similar color patterns between *H. elegans* and *H. albocristata* suggests that the two species may be more closely related to each other than to some other members of the genus. However, a parsimony-based phylogenetic analysis has not been undertaken owing to lack of detailed anatomical data for many species, including the type species.

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Bergh (1905) introduced *Halgerda elegans* from Indonesia and described two color variations: *H. elegans* and *H. elegans* var. *H. elegans* var. differed from *H. elegans* in a few characteristics. One difference was in external coloration; *H. elegans* has orange-yellow lines along the ridge crests, while *H. elegans* var. has yellow spots on the dorsum and no yellow lines along the ridge crests. *Halgerda elegans* var. also has fewer black lines arranged along the mantle edge than *H. elegans* which has many, evenly-spaced black lines. The original drawings of the radula of both varieties indicate the presence of simply hamate teeth with the outer three, fimbriate.

The reproductive systems of both *H. elegans* and *H. elegans* var. were only briefly described.

No additional records of this species or the variant have been published.

The present study examines several specimens of *H. elegans* and compares them to Bergh's original description. Rudman (1978) re-examined several species of *Halgerda* and compiled a list of features which were considered to be distinctive for *Halgerda*. Examination and dissection of four specimens of *H. elegans* and three of the new species described here, revealed differences from Rudman's generic characters which we have noted in this paper. Some of these differences were also discussed by Willan and Brodie (1989) based upon their examination of *Halgerda aurantiomaculata*. Carlson and Hoff (1993) described three new *Halgerda* species

with features both similar and different from those noted by Rudman.

SPECIES DESCRIPTIONS

Family Halgerdidae Odhner, 1926

Genus *Halgerda* Bergh, 1880

Halgerda elegans Bergh, 1905
(Figs. 1A, 2–6)

Halgerda elegans Bergh, 1905: 124–126; pl. 2, fig. 4a; pl. 15, figs. 29–31.

MATERIAL EXAMINED. — CASIZ 079348, one specimen, dissected, 1.3 km ENE of Maeki-zaki, Seragaki Beach, Okinawa, Ryukyu Islands, Japan, 5 m depth, 14 August 1991, R. F. Bolland. CASIZ 070304, one specimen, dissected, Manado, Sulawesi, Indonesia, 13 m depth, 20 May 1989, P. Fiene-Severns. CASIZ 065408, one specimen, dissected, W side Pig Island (Tab Island), Barracuda Point, Madang, Papua New Guinea, 8 m depth, 7 February 1988, T. Gosliner. CASIZ 073072, one specimen, dissected, Barracuda Point, NE corner of Pig Island (Tab Island), Madang, Papua New Guinea, 12 m depth, 15 October 1986, T. Gosliner.

DISTRIBUTION. — This species was originally described from Indonesia (Bergh 1905) and is here reported from Papua New Guinea, Okinawa and Indonesia.

NATURAL HISTORY. — *Halgerda elegans* is found crawling in the open on reefs, rocky surfaces and also under coral rubble from 5–13 m depth. It feeds on unidentified sponges.

EXTERNAL MORPHOLOGY. — The living animals studied are 5–10 mm in length (Fig. 1A). The preserved specimens measure 5–6 × 3 mm. The body is firm and smooth, like gelatin, but rigid. The body profile is high and the dorsum has a series of angled ridges arranged in a reticulate pattern. There are no conical tubercles at the junctions of the ridges, as are present in some other *Halgerda* species. The ground color of the dorsum and foot are translucent white. The ridges are lined in orange-yellow, with additional short lines of the same color on the dorsum near the gill and rhinophores. There are four junctures where the color and ridges meet along the midline of the body; one in front of the rhinophores and three between the rhinophores and the gills. There are short, evenly-spaced black lines

which run perpendicular to the margin and are present around the entire margin. The white viscera can be seen through the dorsum in the living animal.

The upright rhinophores (Fig. 6A) are tapered towards the tip with black subapical coloration and a translucent white background color. There are 11–15 rhinophoral lamellae.

The four branchial leaves are sparsely and irregularly pinnate. The gills have black coloration approximately halfway up the stalk. The pigment completely encircles each branch. Within the gill rachis, running from the base to the apices, are numerous flattened, translucent structures which appear glandular. The anal papilla is translucent white.

BUCCAL ARMATURE. — The buccal mass has no pigmentation on the dorsal side of the oral tube. The radular sac is elongate and curved and the radular ribbon is much longer than it is wide. The radular formulae of three dissected specimens are: 43 × 27.0.27 (CASIZ 065408), 36 × 23.0.23 (CASIZ 070304) and 45 × 31.0.31 (CASIZ 079348). The fourth specimen's teeth (CASIZ 073072) were unable to be counted due to their being extremely narrow, numerous and irregularly arranged (Figs. 5A, B). The 4–5 outer laterals are modified with a series of fimbriate denticles (Fig. 2A). The mid-laterals are hamate with a rounded point at the tip (Fig. 2B). The two inner laterals are also hamate with a flange on the inner side of each tooth (Fig. 2C) and the remaining mid-laterals have long hooks and a secondary flange (Fig. 2D). Three of the specimens examined had elongate teeth, different from the typical dolid hamate teeth (Figs. 3–5). In one of these specimens, most of the teeth were multifid, with pronounced flanges on 5 hamate inner laterals (Fig. 4), and 5 fimbriate outer laterals (Fig. 4A). As mentioned, one of the specimen's teeth were extremely narrow, bi- or trifid, hooked at the tips and had a pronounced inner flange (Figs. 5A, B).

REPRODUCTIVE SYSTEM. — The reproductive system is triaulic (Fig. 6B). The ampulla is tubular and convoluted and protrudes away from the genital mass. The ampulla narrows into the postampullary duct and divides into the vas deferens and oviduct. The oviduct is extremely short and enters the female gland mass. After branching from the ampulla, the short, narrow vas deferens expands into a large tubular prostate, which consists of numerous nodular glands. The mus-

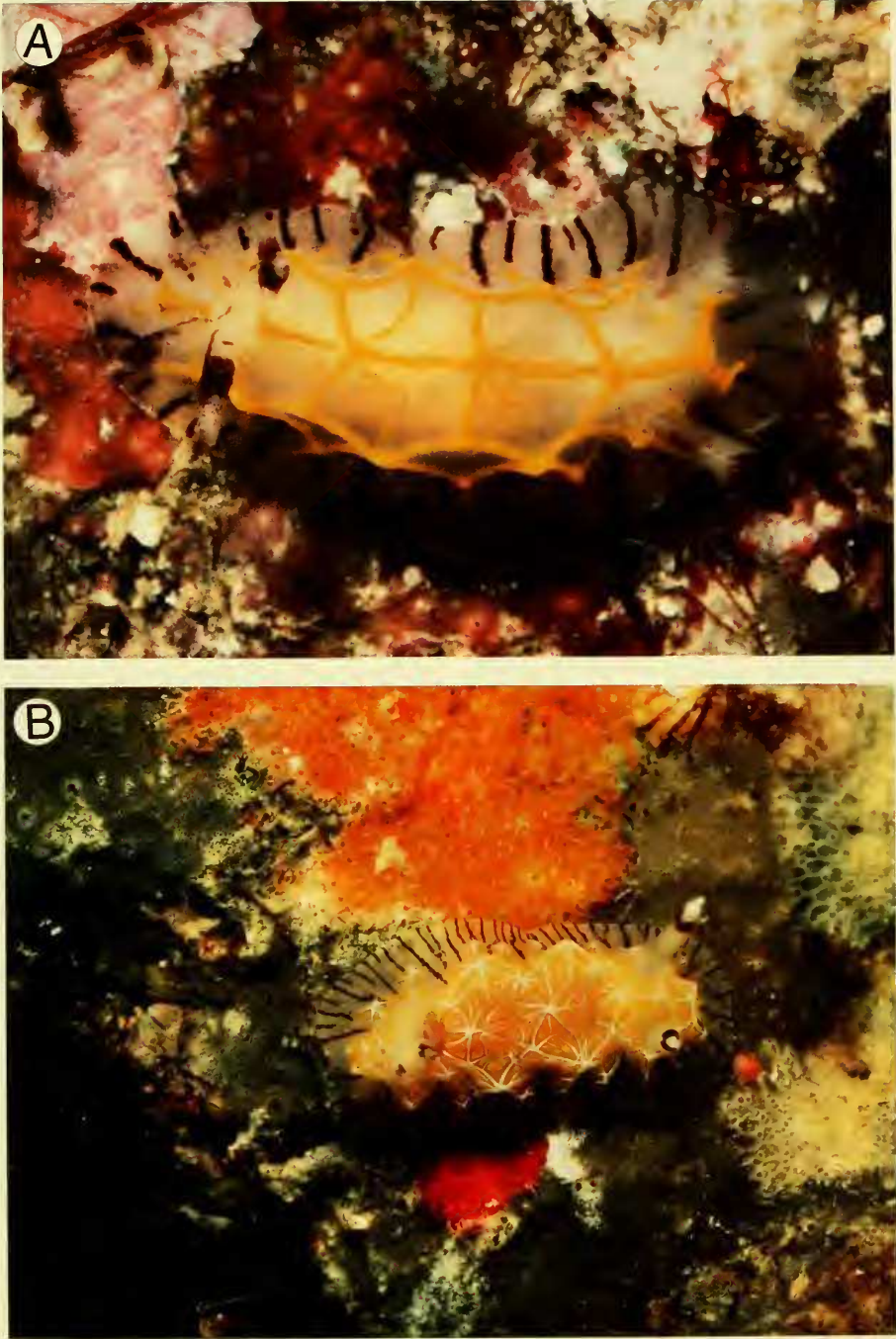


FIGURE 1. Living animals. A. *Halgerda elegans* Bergh, 1905 (CASIZ 065408). Specimen, 6 mm, from west side Pig Island (Tab Island), Barracuda Point, Madang, Papua New Guinea, 8 m depth, 7 February 1988. B. *Halgerda albocristata* sp. nov. (CASIZ 083816). Specimen, 8 mm, from Batangas, Luzon Island, Philippines, 20 m depth, 22 February 1992. Photographs by T. M. Gosliner.

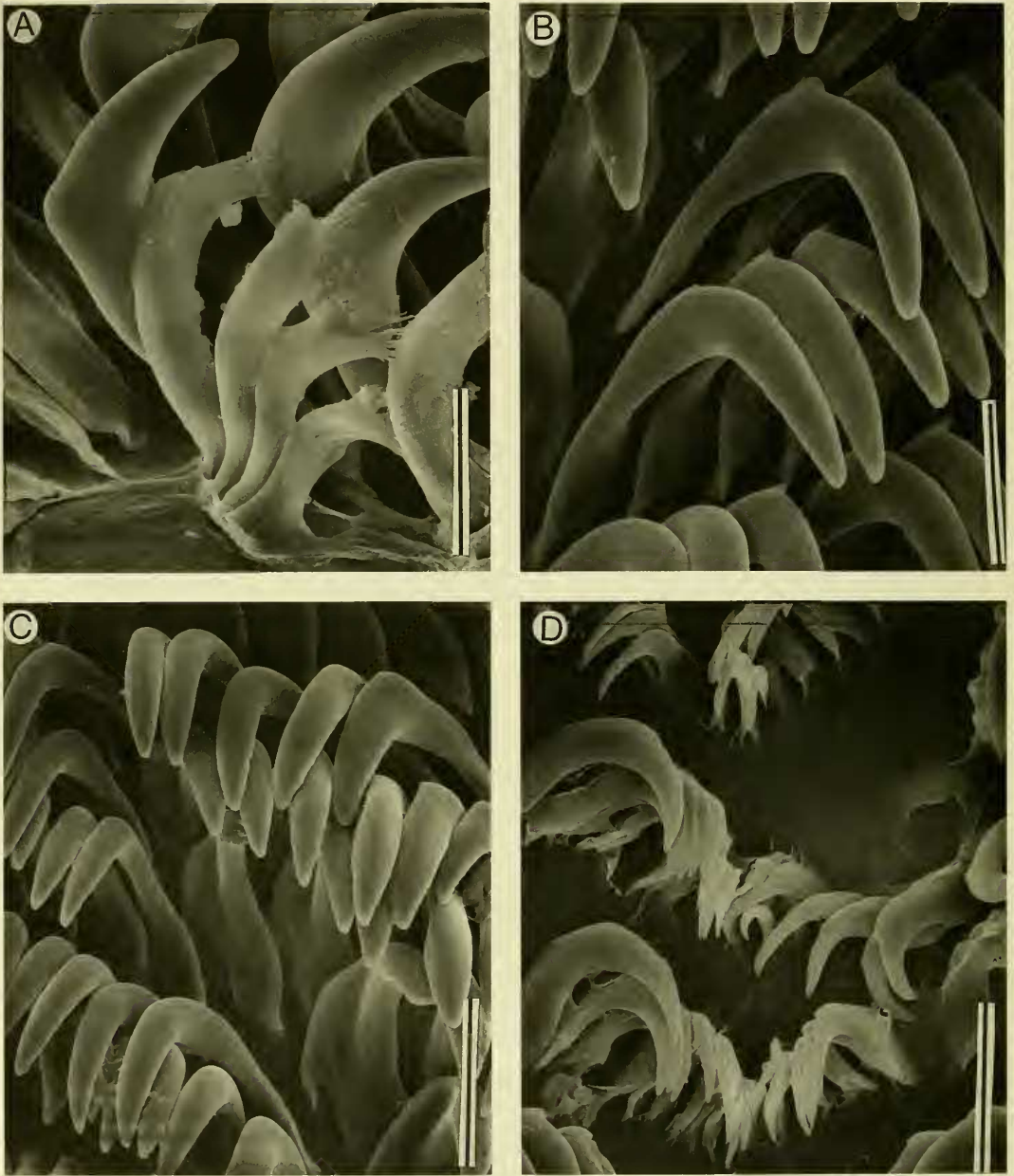


FIGURE 2. *Halgerda elegans* Bergh, 1905 (CASIZ 079348). Scanning electron micrographs of radula. A. Outer lateral teeth, scale = 20 μm . B. Lateral teeth from middle of half row, scale = 25 μm . C. Inner lateral teeth, scale = 43 μm . D. Inner lateral teeth, scale = 20 μm .

cular portion of the vas deferens leaves the wide, glandular prostate as a long, single duct with one half-loop, then enters the narrow penial bulb. The uterine duct is short and emerges from the female gland mass and enters the receptaculum seminis duct near the base of the small, spherical recep-

taculum. The elongate, curved duct from the receptaculum enters the large, spherical bursa copulatrix adjacent to the vagina. The bursa, which is as large as the prostate, is partially tucked into the prostate along one edge. The receptaculum is partially hidden under the bursa

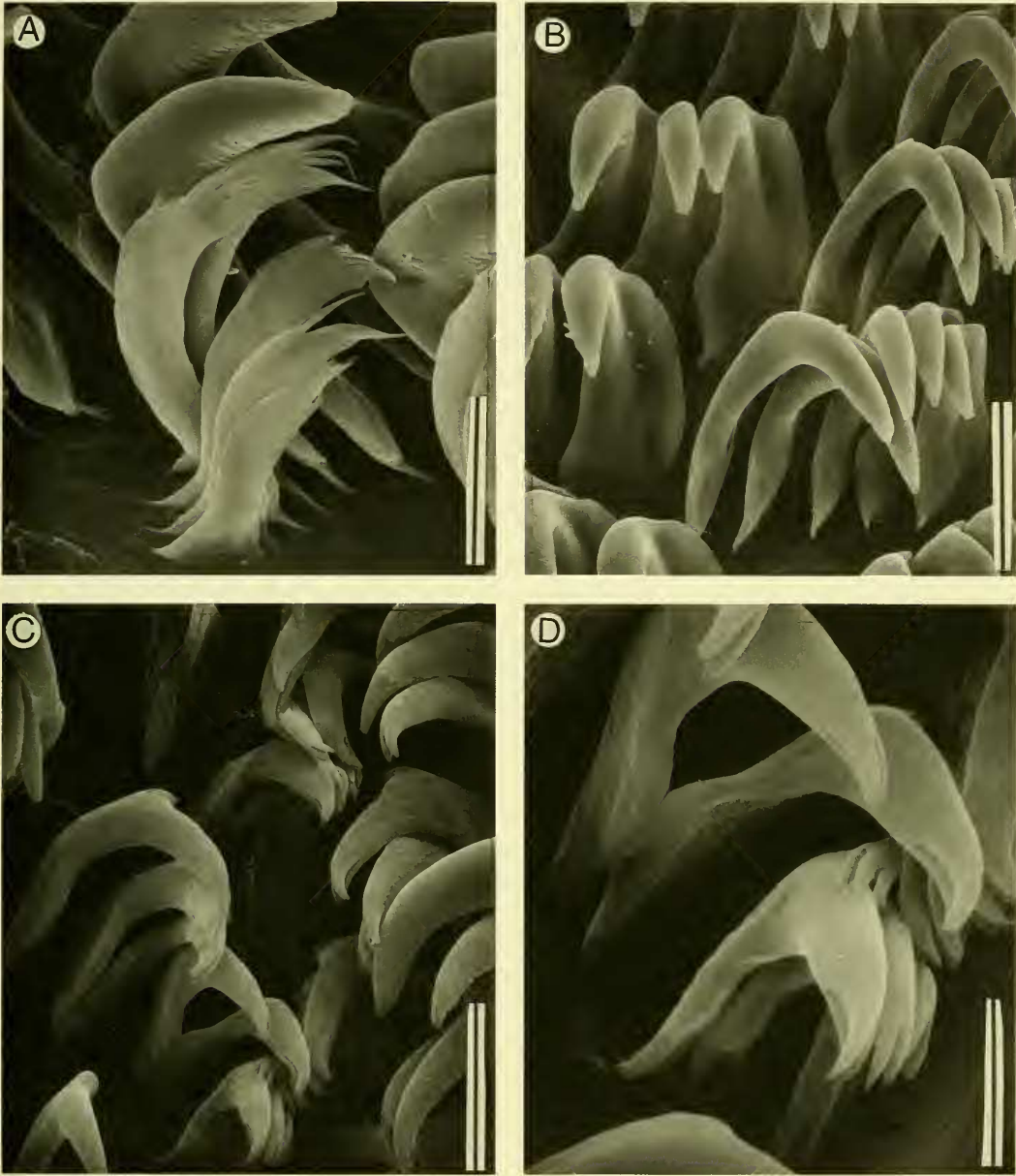


FIGURE 3. *Halgerda elegans* Bergh, 1905 (CASIZ 070304). Scanning electron micrographs of radula variations. A. Outer lateral teeth, scale = 15 μ m. B. Inner lateral teeth, scale = 25 μ m. C. Inner lateral teeth, scale = 10 μ m. D. Inner lateral teeth, scale = 4.3 μ m.

and is also slightly tucked under the prostate. The bursa has been partially extracted in Figure 6 in order that the arrangement of organs can be shown. While the receptaculum and the bursa are both round, the receptaculum is much smaller; barely one-quarter of the size of the bursa. The

vaginal duct is short and has a lobed, glandular base immediately proximal to its junction with the penis. The female gland mass is larger than the prostate gland. The nidimental aperture is wide and large.

Halgerda albocristata Gosliner and Fahey, sp. nov.

(Figs. 1B, 7, 8)

TYPE MATERIAL. — Holotype: CASIZ 083816, one specimen, Bonito Island, Batangas, Luzon Island, Philippines, 20 m depth, 22 February 1992, T. M. Gosliner. Paratypes: CASIZ 070010, one specimen, dissected, Okinawa, 1 km WNW of Onna Village, Horseshoe Cliffs, 26°30'N, 127°50.9'E, Japan 3 m depth, 16 August 1989, R. F. Bolland. CASIZ 078541, two specimens, one dissected, Bunaken Island, Manado, Celebes Sea, Sulawesi, Indonesia, 3 m depth, 8 May 1991, P. Fiene-Severns.

DISTRIBUTION. — This species is known from the tropical western margin of the Pacific Ocean; from Okinawa, the Philippines, Guam and Marshall Islands (C. Carlson and S. Johnson, pers. comm.) and Indonesia (present study).

ETYMOLOGY. — The trivial name, *albocristata*, is chosen from the Latin *alba* meaning white, and *crista* meaning ridge or crest. This name is to distinguish this species with its white ridges from *Halgerda elegans* which has orange-yellow ridge crests.

NATURAL HISTORY. — *Halgerda albocristata* is found crawling in the open on reefs, rocky surfaces and also under coral rubble from 3–20 m deep. It feeds on unidentified sponges.

EXTERNAL MORPHOLOGY. — The preserved holotype is 9 × 5 mm. The living animals are 12–15 mm in length. The preserved specimens are 12–13 × 6 mm. The body is firm and smooth like gelatin, but rigid. The body profile is high and the dorsum has a series of angled ridges arranged in a reticulate pattern. There are no conical tubercles at the junctions of the ridges. The ridges are variably marked with opaque white lines or blotches. There are additional, shorter white lines radiating up to the peaks which may be sparsely or densely arranged (Fig. 1B). The white coloration intersects at many points on the dorsum, but there are four primary mid-dorsal points of juncture. In larger specimens, this intersection may be at low, rounded tubercles and more white pigment is present. The ground color of the dorsum beneath the white ridges is yellow, while along the mantle margin it is translucent white, as is the foot. There are numerous short, evenly-spaced black lines which run perpendicular to the margin and are present

around the entire margin. The posterior end of the foot extends beyond the mantle and has retained its dark spots in preservation.

The erect rhinophores (Fig. 8A) are tapered, being thinner at the tip than at the base. There is patchy black coloration two-thirds up toward the tip and the background color is translucent white. There are 15–18 rhinophoral lamellae.

The 4–6 branchial leaves are pinnate with the two posterior gills being more highly branched than the anterior two. The black coloration on the gills is on the branches only; it is patchy and does not extend to the tips. Within the gill rachis, running from the base to the tips, are numerous flattened, translucent structures which appear glandular.

BUCCAL ARMATURE. — The buccal mass has dark pigmentation on the dorsal side of the oral tube. The radular sac is elongate and curved extending well posterior of the buccal mass. The radular ribbon is longer than it is wide. The radular formulae of the two dissected specimens are: 56 × 27.0.27 (CASIZ 078541) and 61 × 37.0.37 (CASIZ 070010). The 3–4 outer laterals are modified with a series of fimbriate denticles (Fig. 7A). The mid-laterals are hook-shaped with a pointed crest (Fig. 7B). The 5 or so inner laterals are hooked with an inner flange (Fig. 7C).

REPRODUCTIVE SYSTEM. — The reproductive system is triaualic (Fig. 8). The wide ampulla is flattened and curved. It lies tightly against the female gland mass. The female gland mass is large, about the same size as the prostate gland. The ampulla narrows into the postampullary duct, bifurcates into the vas deferens and oviduct. The short oviduct enters the female gland mass. The short vas deferens separates from the ampulla and widens into the large, glandular prostate. The muscular portion of the vas deferens leaves the prostate in a long, single duct with one half-loop, then widens into the penial bulb. The short uterine duct emerges from the female gland mass and joins the receptaculum seminis duct near the middle of its length. The receptaculum duct is moderately long and joins the pyriform receptaculum seminis with the slightly larger, spherical bursa copulatrix adjacent to the vagina. One edge of the bursa is partially covered by the much larger prostate. The receptaculum is partially hidden under the bursa and is also slightly tucked under the prostate. The vaginal duct

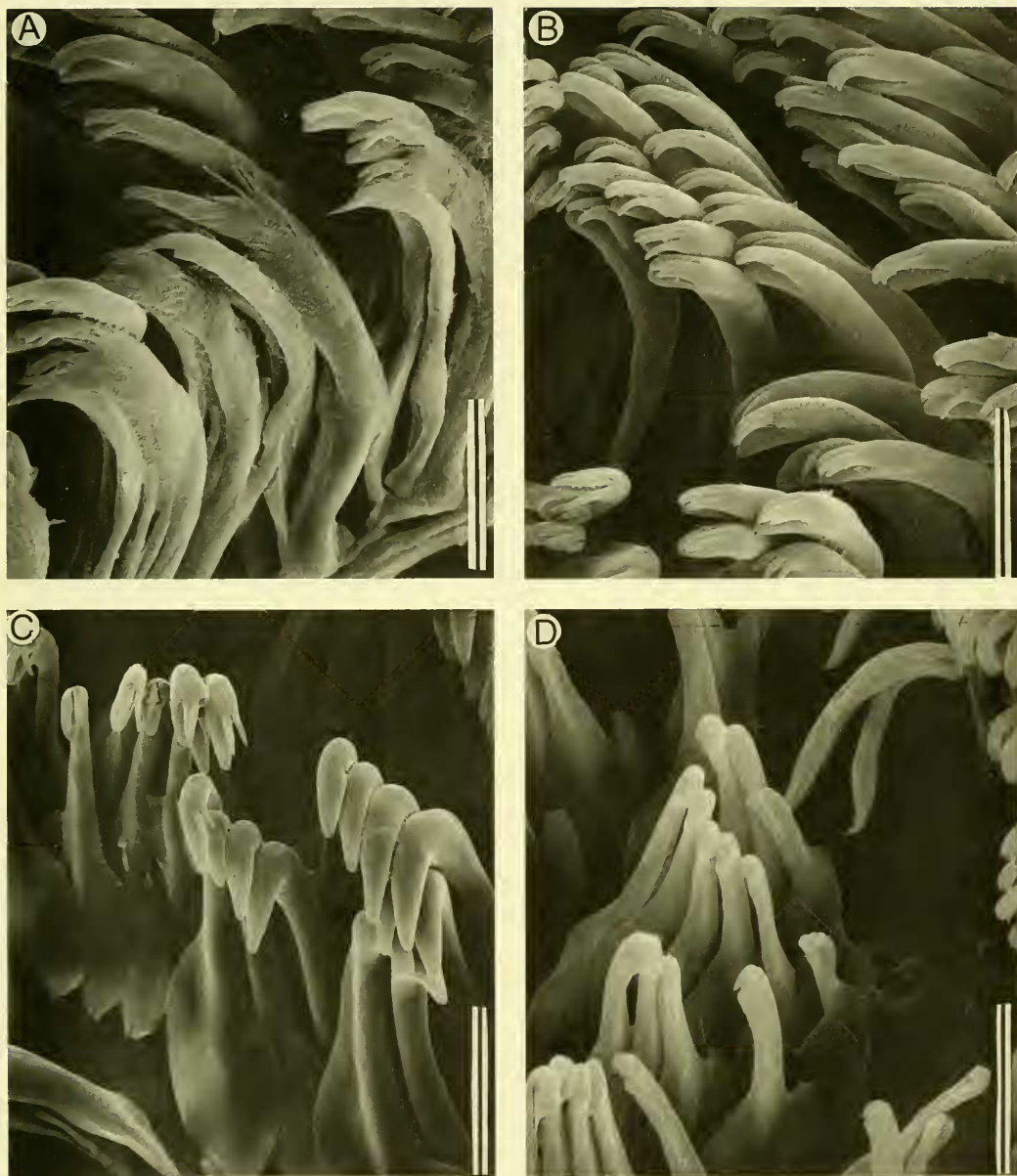


FIGURE 4. *Halgerda elegans* Bergh, 1905 (CASIZ 065408). Scanning electron micrographs of radula variations. A. Outer lateral teeth, scale = 15 μ m. B. Lateral teeth from middle of half row, scale = 15 μ m. C. Inner lateral teeth, scale = 20 μ m. D. Inner lateral teeth, scale = 10 μ m.

which emerges from the base of the bursa copulatrix is long.

At its distal end, just prior to its exit adjacent to the base of the male aperture, is an enlarged, but undivided portion which is not obviously glandular. The genital aperture is wide and large.

DISCUSSION

Bergh (1905) described a *Halgerda* species from Gunong-API, which is in the Banda Sea, Indonesia, Pacific Ocean, not the Indian Ocean, as originally indicated by Bergh. He named this

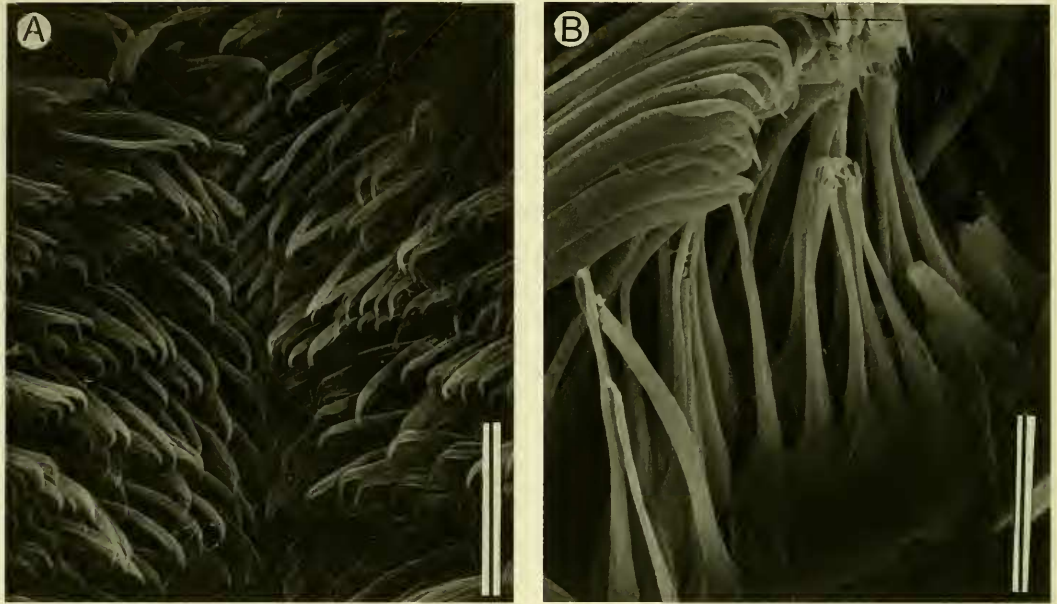


FIGURE 5. *Halgerda elegans* Bergh, 1905 (CASIZ 073072). Scanning electron micrographs of radula variations. A. Inner lateral teeth, scale = 15 µm. B. Lateral teeth from middle of the half row, scale = 10 µm.

orange-yellow ridged species with many black perpendicular lines along the edge of its mantle. *Halgerda elegans*. He also named a similar species with yellow spots, no colored lines and only a few black mantle-edge lines as *H. elegans* var. Examination of recent material collected from Okinawa, Papua New Guinea and Indonesia, with morphological similarities to *H. elegans* indicate that these orange-yellow lined species are *H. elegans*, while specimens collected with white lines represent a new species, *H. albocristata*.

Bergh's description of the reproductive systems of *H. elegans* and *H. elegans* var. was very limited, with no details given of the organs or comparisons made between the two variants.

It is unlikely that *H. elegans* var. is a variant of *H. elegans*, based on the difference in color. However, there are no specimens of this material with Bergh's type material at the Zoology Museum of the University of Copenhagen. There are several distinct differences between the specimens of *H. elegans* and *H. albocristata* examined during this study. In addition to the external difference of white versus yellow lines on the notal ridges, the orange-yellow lined specimens (*H. elegans*) have no secondary or smaller simi-

lar colored lines in the concavities of the ridges. In contrast, the white lined specimens (*H. albocristata*) have additional, shorter white lines connecting the ridge lines. There is also the difference in the arrangement and length of the dark lines which lie perpendicular to the mantle edge. In *H. elegans*, these lines are wider but there are fewer of them. In *H. albocristata* these lines are narrower but more numerous along the mantle edge.

In *H. albocristata*, there is yellow pigment in the ridge concavities on the dorsum, whereas in *H. elegans*, there is no pigment. In all preserved specimens examined of both species, the body is translucent white with the yellowish viscera showing through.

Gill glands are visible in both *H. elegans* and *H. albocristata* and both species have dark coloration, which does not extend to the tips of the branchial leaves.

Pigmentation also differs in the buccal mass. There is dark pigmentation on the buccal mass between the eyes of *H. albocristata* while in *H. elegans* no pigmentation was evident.

The length of the radular sac is similar in *H. elegans* and *H. albocristata*, both being elongate and curved. The outer lateral teeth of both species

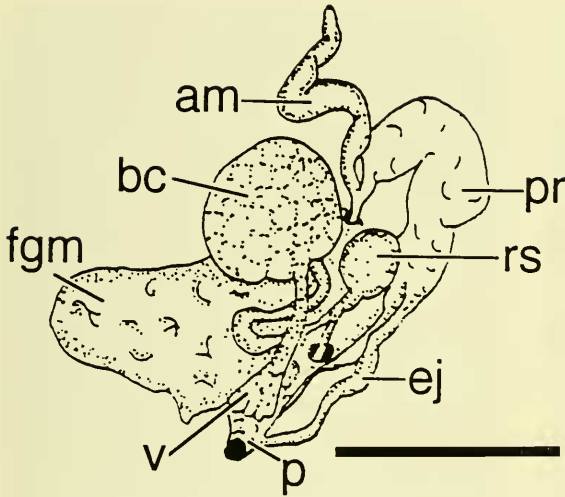


FIGURE 6. *Halgerda elegans* Bergh, 1905 (CASIZ.079348). Detail of reproductive system, am = ampulla, bc = bursa copulatrix, ej = ejaculatory duct, fgm = female gland mass, p = penis, pr = prostate, rs = receptaculum seminis, v = vagina, scale = 0.5 mm.

are fimbriate and the inner-most laterals are hamate with a secondary flange. *Halgerda elegans* exhibits a wide variation in tooth structure, ranging from simple hamate to multifid mid-laterals (Figs. 2–5). Also, the number of teeth appears to vary widely between specimens (Fig. 5). The ratio between the number of rows of teeth vs. the number of teeth per half row does vary between species (Fig. 9) with *H. albocristata* having more rows of teeth than *H. elegans*.

The anatomy of the reproductive system differs between *H. elegans* and *H. albocristata* in several distinct ways:

1) size of the bursa copulatrix vs. the receptaculum seminis: *H. elegans* has a much smaller receptaculum compared to the bursa, while the bursa and receptaculum of *H. albocristata* are approximately the same size.

2) presence of a vaginal accessory gland: *H. elegans* has a lobed accessory gland, whereas there is no distinct vaginal accessory gland in *H. albocristata*.

3) length of the vaginal duct: in *H. albocristata*, the vaginal duct is elongate and slender, whereas in *H. elegans*, this duct is short.

4) length of the duct connecting the receptaculum and the bursa: in *H. elegans*, this duct is much longer than the vaginal duct, whereas in *H.*

albocristata, this duct is much shorter than the vaginal duct.

Included in Carlson and Hoff's (1993) and Willan and Brodie's (1989) descriptions of *Halgerda* species, was a review of the literature on *Halgerda* and comparison of some of the similarities between species. These similarities included an oval body outline and a firm, gelatinous body texture, which was also found in the specimens examined for this study. Carlson and Hoff noted that *Halgerda* species may or may not have tubercles at the ridge junctures. This is consistent with the *Halgerda* species examined for this paper. Carlson and Hoff (1993) also discussed the mid-dorsal pattern of ridge junctures which appears in some figures, such as in Bergh's drawing (1905, pl. 2, fig. 4a) of *H. elegans*, *H. tessellata* Bergh (1880a), and *H. aurantiomaculata* Willan and Brodie (1989).

Halgerda elegans specimens examined during this study also had this same pattern in coloration. This pattern was not evident in *H. albocristata* in which the white-lined ridges intersect at many more points, but have four primary mid-dorsal points of juncture.

Carlson and Hoff (1993) also noted the flange on the inner edge of the lateral teeth and the pectinate outer laterals. These features were also present in both *H. elegans* and *H. albocristata* examined during this study. However, the large denticle on the inner edge of the innermost pectinate tooth was not noticeable in any of the specimens examined. Willan and Brodie (1989) confirmed that *H. aurantiomaculata* has an elongate radula, which is also present in all the specimens examined during this study.

The family name Halgerdidae was introduced by Odhner (1926) for *Halgerda* and *Asteronotidae* was introduced by Thiele (1931) for *Asteronotus*. Odhner in Franc (1968) suggested that both family names are synonymous. Since Halgerdidae is the oldest available name we place *Halgerda* in Halgerdidae pending a complete phylogenetic analysis.

Others (Willan and Coleman 1984; Rudman 1998) have joined most of the cryptobranch dorids into the single family Dorididae, with or without employing a series of subfamilies.



FIGURE 7. *Halgerda albocristata* sp. nov. (CASIZ 070010). Scanning electron micrographs of radula. A. Outer lateral teeth, scale = 25 μ m. B. Lateral teeth from middle of the half row, scale = 43 μ m. C. Inner lateral teeth, scale = 25 μ m.

Comparison was made with other generic characters of *Halgerda* described by Rudman (1978) as part of this study. Rudman described the membrane surrounding the viscera as being very dark brown or black in most specimens of *Halgerda* he studied. However, in living specimens of *H.*

elegans and *H. albocristata*, the membrane was white or yellowish, as is found in most other dorids. In the preserved animals, the membrane had no distinct color, but is slightly yellowish when compared to the internal organs. Willan and Brodie (1989) also confirmed that at least

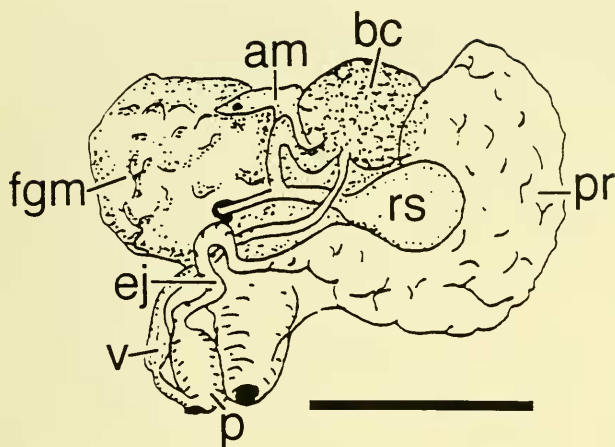


FIGURE 8. *Halgerda albocristata* sp. nov. (CASIZ 070010). Detail of reproductive system, am = ampulla, bc = bursa copulatrix, ej = ejaculatory duct, fgm = female gland mass, p = penis, pr = prostate, rs = receptaculum seminis, v = vagina, scale = 1 mm.

two other species, *H. carlsoni* and *H. aurantiomaculata*, have a translucent visceral envelope.

Another characteristic of the genus *Halgerda* as described by Rudman was the number of teeth in the radula. He noted about fifty teeth in each half row. In the specimens discussed herein, radula were found to have approximately twenty to forty teeth per half row, except for the variations noted. Rudman (1978) suggested that an enlarged curved radular sac was typical of the genus. This was confirmed for the species examined here, by Willan and Brodie (1989) and by Carlson and Hoff (1993) for *H. guahan*. The presence of a glandular prostate which ensheathed the bursa was thought to be present in all members of the genus (Rudman, 1978). But in specimens examined here, this was not the case. Rather than having the bursa copulatrix almost completely enclosed in the prostate gland as described by Rudman (1978) and Willan and Brodie (1989), the prostate gland in both species examined here, lies alongside the bursa, with only an edge of the bursa tucked into the prostate. Thus this characteristic is not shared by all members of the genus.

The rhinophores of *Halgerda elegans* and *H. albocristata* are not as distinctly differentiated as other dorids. The stalks are long relative to the club, and the base is very broad. The rhinophores

of *H. elegans* are not especially long for the animal's size whereas those of *H. albocristata* are somewhat longer. Willan and Brodie (1989) also confirmed long, tapering rhinophores in *H. carlsoni* and *H. aurantiomaculata*. In addition, the rhinophores of both *H. elegans* and *H. albocristata* are upright and do not angle either posteriorly or anteriorly. The pigmentation on the rhinophores of both species is dark and patchy, covering only the top third of the rhinophore, leaving the tips white. Dark markings were noted by Rudman (1978) as being present in all the species described in that paper.

These differences confirm that some of the *Halgerda* characteristics listed by Rudman in 1978 may not hold true for all species within the

genus as noted by Willan and Brodie (1989).

Further work with other species of the genus *Halgerda* will likely provide additional insight.

The following characteristics appear to be consistent for all members of the genus. It is a modified list of the characters presented by Rudman in 1978.

- 1) A smooth, gelatinous, yet firm body
- 2) A large gill which is sparsely pinnate
- 3) The openings to the rhinophore and gill pockets are smooth
- 4) The radular sac is elongate and curved
- 5) Rhinophoral stalks which are long relative to the club

From this study, it appears that many of the characteristics of *H. elegans* and *H. albocristata* are similar and a testable hypothesis of phylogeny is needed to determine how closely these two species are related compared to other *Halgerda* species.

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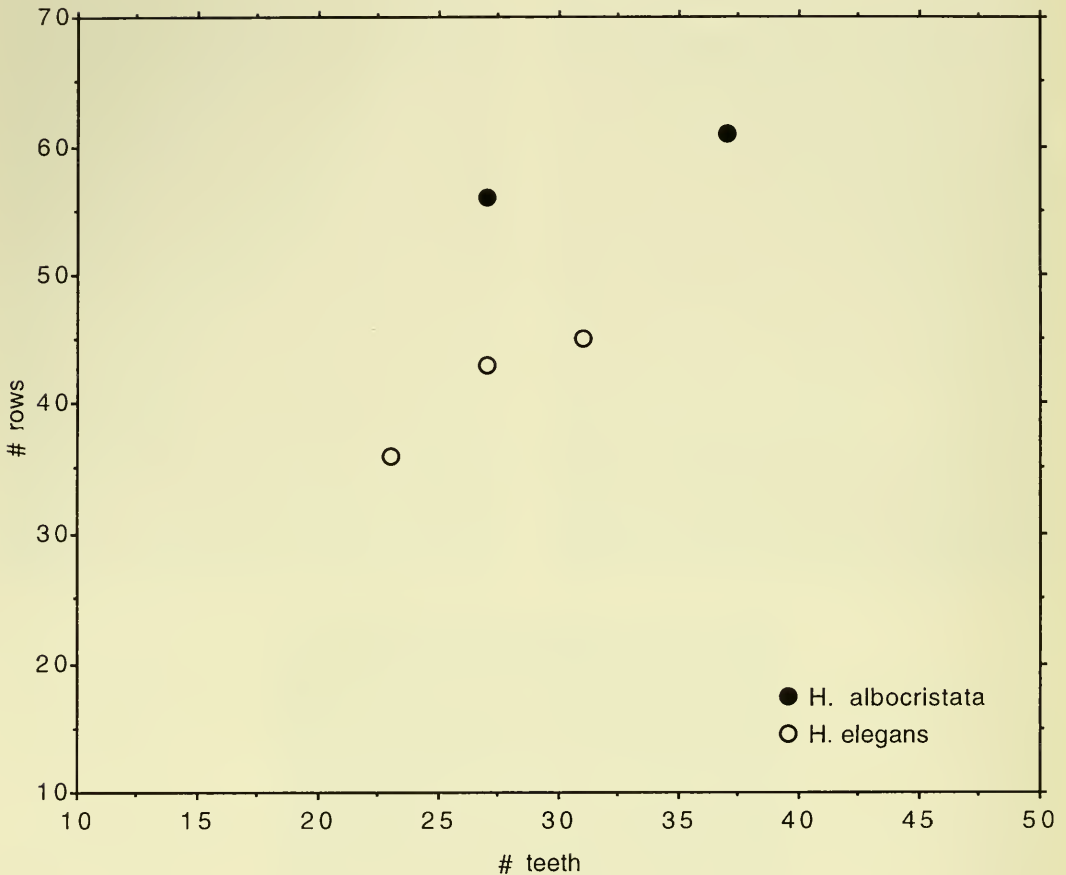


FIGURE 9. Graph of number of rows of teeth versus number of teeth per half row, *H. elegans* versus *H. albocristata*.

of specimens from Guam and the Marshall Islands. Ángel Valdés graciously reviewed the manuscript and provided valuable comments.

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